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THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR
C. A. CHANT
University of Toronto, Toronto

ASSOCIATE EDITORS
J. S. PLASKETT
Director of the Dominion Astrophysical Observatory, Victoria, B.C.
SIR FREDERIC STUPART
Director of the Meteorological Service of Canada, Toronto
R. MELDRUM STEWART
Director of the Dominion Observatory, Ottawa

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Vol. XXI, No. 3 MARCH, 1927 Whole No. 163

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THE JOURNAL
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VOL. XXI, No. 3 MARCH, 1927 Whole No. 163

REPORT OF THE ANNUAL GENERAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Meeting was held on the evening of January 18, 1927, in the Physics Building of the University, the President, Mr. A. F. Hunter, in the chair.

The minutes of the last Annual Meeting were taken as read.

Reports from the various centres were read by the President showing some progress made during the year.

The financial statement prepared by the General Treasurer, Mr. H. W. Barker, was also presented and approved.

The President explained that ballots had been sent out to all the members calling for the election of officers for the year 1927. Ballots had been returned, so scrutineers were appointed, Mr. Collins and Miss Budd acting in this capacity. Mr. Collins afterwards announced the result as follows: Total number of ballots received, 85. The names given on the ballot paper were unanimously approved, in 19 cases other names were suggested in the place of Sir Joseph Pope who had died since nomination. The President then announced the following as duly elected:

Honorary President: Hon. G. Howard Ferguson, K.C., B.A., LL.D., Minister of Education for Ontario.
President; A. F. Hunter, M.A., Toronto.
First Vice-President: Wm. Bruce, J.P., Hamilton.
Second Vice-President: R. K. Young, Ph.D., Toronto.
General Secretary: F. T. Stanford, Toronto.
General Treasurer: H. W. Barker, Toronto.
Recorder: E. J. A. Kennedy.

Librarian: C. A. Chant, M.A., Ph.D.
Curator: Robert S. Duncan.
Council: Mgr. C. P. Choquette, M.A., Lic.Scs., Montreal; R. E. DeLury, Ph.D., Ottawa; J. B. Fraser, M.D., Toronto; R. A. Gray, B.A., Toronto; A. R. Hassard, B.C.L., Toronto; J. H. Horning, M.A., Toronto; Prof. J. Matheson, Kingston; John Satterly, M.A., D.Sc., Toronto; Dr. W. M. Wunder, Toronto.

The death of Sir Joseph Pope was referred to, which leaves a vacancy on the Council. Nominations to fill this vacancy were received but as three names received the same number of votes it was resolved, in accordance with the constitution, to leave the decision in the hands of the General Council.

A letter was received from Mr. John Walkden, son-in-law of Mr. Wm. Bruce, of Hamilton, Vice-President, to the effect that it was Mr. Bruce's wish to be relieved of the responsibility of office.

Mr. Bruce, a much respected officer of this Society is now over 90 years of age and confined to his bed with little hope of recovery. The meeting expressed its regret and referred to his great and life-long interest in the affairs of the Society, and referred this letter to the General Council.

It was also resolved that a letter of condolence be forwarded to the mourning relatives of Sir Joseph Pope.

The Membership on December 31, was as follows:

	1926	1925
Toronto, City Members	103	102
Toronto, Outside Members	146	137
Ottawa Centre	62	62
Winnipeg Centre	50	47
Montreal Centre	104	84
Victoria Centre	64	67
London, Ont. Centre	42	41
	571	540
Life Members	12	12
Honorary Fellows	12	11
	595	563

E. M. Budd,
Assistant Secretary

Following are the reports of the Librarian, of the Secretary for each Centre, of the General Treasurer and the Treasurers of the Centres.

Report of the Librarian

During the year 1926 the number of periodicals received was somewhat larger than in previous years There was also an increase in the number of exchanges, especially from abroad, indicating increased activity as the nations recover from the disastrous effects of the war.

Number of periodicals received:	
From Canada and the Empire	160
From the United States	181
From other countries	176
Total	517
Journal sent in exchange to addresses in:	
Canada and the Empire	44
The United States	51
Other countries	52
Total	147

The number of volumes borrowed from the library was larger than in previous years.

Among the books (other than periodicals) added to the library were the following:

The Earth and the Stars, by C. G. Abbot.
The Universe of Stars, Radio Talks at Harvard Observatory.
Starlight, by Harlow Shapley.
Meteors, by C. P. Olivier.
Stars and their Uses, by E. B. Leggett (in verse).
Astronomy of To-day, by T. Moreux.
Astronomical Physics, by F. J. M. Stratton.
Modern Astrophysics, by H. Dingle.
Clouds and Weather Phenomena, by C. J. P. Cave.
The Recent Total Eclipse of the Sun, by S. A. Mitchell.
The Wonder and the Glory of the Stars, by G. Forbes.
John A. Brashear, an Autobiography.
Life of Galileo, by Sister Mary Celeste, 1870.

Rain Making and other Weather Vagaries, by W. J. Humphreys.
Fogs and Clouds, by W. J. Humphreys.
The North American Almanac, 1927.

As noted in past years, the accommodation for the library is very unsatisfactory, but nothing better is in sight at present.

C. A. CHANT, *Librarian.*

TORONTO CENTRE

The following papers and addresses were read or delivered at the meetings in Toronto:

Jan. 26—R. Meldrum Stewart, M.A.—Some Recent Advances in Astronomy.
Feb. 9—A. R. Hassard, B.C.L.—Mirages and Other Summer Observations.
Feb. 23—Prof. H. A. MacTaggart—The History of Spectacle Lenses.
Mr. A. F. Miller—The Theory of Eternal Return, and Astronomy (a translation of Pierre Salet's article in *L'Astronomie*).
Mar. 9—Mr. A. F. Miller—Pepys as an Astronomer, and the Science of his Time.
Mar. 23—John Patterson, M.A., F.R.S.C.—The Importance of Water Vapour in the Atmosphere.
April 6—Motion Pictures of Astronomical Phenomena (Mr. F. T. Stanford).
Prof. C. A. Chant—An Outline of the Work of the Royal Astronomical Society of Canada.
April 20—Motion Pictures of Astronomical Phenomena.
May 4—Rev. Dr. D. B. Marsh—Astronomical and Seismological Work and Experiences in the Bermudas and the West Indies.
Oct. 19—A. F. Hunter, M.A.—Recent Work in Astronomy, and its Allied Subjects, in Canada.
Nov. 2—Prof. C. A. Chant—Foucault's Pendulum and the Rotation of the Earth—A Practical Demonstration and its Explanation.
Mr. F. T. Stanford—A Series of Astronomical Lantern Pictures.
Nov. 16—Mr. A. F. Miller—John Flamsteed, the First Astronomer Royal.
Nov. 30—Prof. C. A. Chant—Experiments in Light—Fluorescence.
Motion Pictures of Astronomical Phenomena (Mr. F. T. Stanford).
Dec. 14—A. R. Hassard, B.C.L.—Summer Speculations in Astronomy.

An informal meeting for papers and telescopic observations was also held at the residence of Mr. A. F. Miller on June 9.

OTTAWA CENTRE

The Annual Meeting of the Society was held in the Victoria Memorial Museum on December 10, 1926, with the President, Mr. C. R. Coutlee in the chair.

The report of the Treasurer showed a balance in bank of $60.69.

The Secretary's report showed a present membership of 63, the same as last year, for although 3 new members were added 2 resigned and one died during the year.

There were five addresses during the year:

R. Meldrum Stewart, M.A., Some Recent Advances in Astronomy;
R. J. Fraser, C.E., Charting Canada's Coastal Waters;
Dr. R. K. Young, Scientific Facts made Simple;
R. Glen Madill, Magnetic Variation;
C. R. Coutlee, C.E., The Moon's Work on Canada's Coast.

The election of officers for 1927 resulted as follows:

President: Dr. H. M. Ami.
Vice-President: C. C. Smith, B.A., D.L.S.
Secretary: A. H. Hawkins, D.L.S.
Treasurer: J. F. Fredette, D.L.S.
Council: W. W. Nichol, B.A.; J. S. Lane, B.A.; Dr. T. L. Tanton and all Past Presidents.

A. W. GRANT, *Secretary.*

MONTREAL CENTRE

During the Session 1925-26 five regular meetings were held in the Macdonald Physics Building, one in the Royal Victoria College jointly with the Sigma Xi Society of McGill University, and three special meetings in the Mechanics Institute, the lecturers and topics being as follows:

Mr. Leon Campbell, Harvard Observatory—Variable Stars and the American Association of Variable Star Observers.
Dr. F. Henroteau, Ottawa—Variable Stars of Cepheid Type.
Miss A. Vibert Douglas—The Yerkes Observatory and its Work.
Mr. R. G. Madill, Ottawa—The Earth's Magnetism.
Dr. W. J. Humphreys, Washington—Clouds and Cloud Phenomena.
Prof. A. N. Whitehead, Cambridge—The Ether of Events.

The special educational meetings were organized and addressed by the Vice-president Mr. Asbury, two members having portable telescopes loaning them for the occasions.

Twenty new members were elected during the year making the total membership at this date 104.

A. V. DOUGLAS, *Secretary.*

London Centre

The year which has just closed is the sixth year since the inauguration of the London Centre of the R.A.S.C. We began the year 1926 with a membership of 41. During the year four members resigned their membership but five new names were added, so that at the present time we have a paid up membership of 42. Three new members have been added for the year 1927. The meetings during this year were well attended, the average attendance for the year, not including the June observatory meeting, was 26. There has been no falling off in interest in the study of Astronomy. During the year Dr. Kingston delivered the following addresses: Two addresses on The Geography of the Skies, an address on The Distances of the Stars, one on The Constitution of the Stars, and one on The Autumn Skies. Mr. T. C. Benson gave an address on Orion and Dr. E. T. White an address on Variable Stars. On June 19 the annual picnic and observation meeting was held at Mr. W. E. Saunders' farm. Very successful observations were made of sun spots, of the moon and of the planet Saturn. A very enjoyable time was spent by the members and their friends.

E. T. White, *Secretary.*

Winnipeg Centre

During the year 1926 the Society held six regular meetings in the University of Manitoba.

Executive Meetings were held on two occasions at the residence of the Vice-President, Mrs. E. L. Taylor, 288 Wellington Crescent.

Ten new members were elected during the year. There are now 49 members on the roll.

The dates of the regular meetings, the lecturers and the subjects of the lectures were as follows:

Jan. 20—Prof. L. A. H. Warren, M.A.—The Great Telescopes of the World and the Wonders they Reveal.

Feb. 17—E. W. Montgomery, Esq., M.A., M.D., F.A.C.P.—The Oldest Living Things.

Mar. 24—Mr. A. W. Meggett—The Starry Skies in March.
Mrs. E. L. Taylor read a recently published article by Henshaw Ward, entitled "The Candle of Astronomy" at this meeting.

April 14—Mr. H. B. Allan—The Summer Evening Skies.

Nov. 10—Rev. T. W. Morton, B.Sc.—A Trip to Mars.

Dec. 8—Mr. H. B. Allan—The Moon and the Planets Saturn and Jupiter.

The meetings during the year were fairly well attended and were open to the public.

The annual meeting was held on December 8th, when the Officers for 1927 were elected.

The Officers are as follows:

President: Mrs. E. L. Taylor.
Vice-President: Professor L. A. H. Warren, M.A.
Treasurer: Mr. H. B. Allan.
Secretary: Mrs. S. C. Norris.
Assistant Secretary: Mr. C. F. Ellis.
Council: Rev. T. W. Morton, B.Sc.; Mr. A. W. Meggett; Mr. D. R. P. Coats; Mr. D. Saunders; Mr. J. H. Kolb; Mr. Cecil Roy.

S. C. NORRIS, *Secretary.*

VICTORIA CENTRE

During the past year the society has had three council meetings, and eight regular meetings, at which the attendance has been very good.

The dates and titles of the addresses given before the society are as follows:

Feb. 9—Mr. W. E. Harper—Famous Observatories and their Work.
Mar. 9—F. Napier-Denison—Abnormal Weather Conditions of 1925-1926.
April 13—Mr. J. Duff, M.A., Affirmative Mr. R. G. Miller, Negative—Debate on the habitability of the Planet Mars.
May 11—Rev. Dean Quainton—Astronomy of the Bible.
May 21—Outdoor meeting at the Astrophysical Observatory.—Address by Dr. Plaskett, F.R.S.
Oct. 12—Prof. Shrum, University of B.C.—Some Fundamental Concepts of the Atom.
Nov. 16—Prof. Buchanan of the University of B.C.—Rejuvenation of the Stars.
Dec. 14—Annual Meeting, Review (Prof. P. H. Elliott).

Officers for 1927.

President: Prof. P. H. Elliott.
Hon. President: F. Napier-Denison.
Vice-President: J. A. Pearce.
Sec.-Treasurer: R. G. Miller.
Council: J. P. Hibben; E. E. Blackwood, H. H. Plaskett, Rev. J. Goodfellow; and past presidents, J. S. Plaskett, F.R.S., W. S. Drewry, J. E. Umbach, W. E. Harper and John Duff.

Membership.

The total membership now standing on the books is 71 as per list attached.

R. G. MILLER, *Secretary.*

ROYAL ASTRONOMICAL SOCIETY OF CANADA

FINANCIAL STATEMENT FOR YEAR ENDING DECEMBER 31, 1926
GENERAL ACCOUNT

RECEIPTS, 1926

Cash in Bank December 31, 1925	$2,455.16
Grant from City of Toronto	100.00
University of Toronto (50 Journals)	100.00
Balance returned from Hamilton Centre	33.37
Fees of Members	906.05
Interest on Bank Account	74.89
	$3,669.47

DISBURSEMENTS, 1926

Publication JOURNAL and HANDBOOK	$1,604.11
Public Meetings	173.68
Library-books purchased and binding	91.86
Salaries—Assistant Librarian and Caretaker	430.00
Stationery, Stamps, etc	257.09
Rent of Rooms	120.00
Gold Medal	30.00
Telescopes Repaired	51.50
Grants—Ottawa Centre	70.00
Winnipeg Centre	21.00
Montreal Centre	71.00
Victoria Centre	56.50
London Centre	41.00
Miscellaneous Expenses	18.01
Balance in Bank	633.72
	$3,669.47

BUILDING ACCOUNT

RECEIPTS

Balance December 31, 1925	$520.04
Interest	150.96
Balance in Bank	$671.00

Bonds held by Imperial Bank	
Canada Permanent	$1,500.00
Dominion of Canada	1,000.00
	$2,500.00

LIFE MEMBERSHIP ACCOUNT

Receipts

Balance December 31, 1925	$50.00
Interest	1.12
Balance in Bank	$51.12

(Signed) H. W. Barker,
General Treasurer.

Audited and found correct,
January 12, 1927
(Signed) A. R. Hassard,
J. B. Fraser,
Auditors.

OTTAWA CENTRE

Treasurer's Report for 1926

The total Receipts and Expenditures for the year are made up as follows:

Receipts

Balance from 1925	$40.97
Grant from General Treasurer	70.00
Interest	1.89
Total Receipts	$112.86

Expenditures

Advertising	$14.00
Printing	7.52
Meetings (Lecturer's expenses)	25.00
Postage	5.30
Incidentals	.35
Total Expenditures	52.17
Balance on hand	60.69
Grand total	$112.86

The total amount of fees collected during the calendar year of 1925 was $138.00, $20.00 of which were received after the last annual meeting.

This year, so far, the collection of fees amounts to $84.00, leaving $58.00 out-

standing; 17 members are in arrears for the current year, and six are in arrears for two years.

(Signed J. F. FRÈDETTE,
Local Treasurer.

Examined and found correct,
(Signed) R. J. McDIARMID.
Ottawa, December 10, 1926.

MONTREAL CENTRE

Year beginning November 1, 1925, ending November 1, 1926

RECEIPTS

Balance carried forward from last year	$102.74
3 Fees collected for 1925	6.00
77 Fees collected for 1926	154.00
Grant from General Treasurer	71.00
Bank Interest	2.56
	$336.30

DISBURSEMENTS

Remitted fees to General Treasurer	$160.00
Expenses—Lecture, Dr. Henroteau	16.90
Lecture, Dr. Campbell	36.35
R. G. Madill	11.50
H. E. Asbury (Special Lectures)	26.76
Lecture, Prof. A. N. Whitehead	25.00
Postage and Stationery	11.40
Janitor service at meetings	6.00
Lantern service at meetings	6.00
Miscellaneous	.15
Cash on hand, Treasurer	6.94
Cash on hand, Secretary	5.40
Balance in Bank	23.90
	$336.30

LONDON CENTRE

Treasurer's Financial Statement December 11, 1925 to December 10, 1926

RECEIPTS

Balance carried forward, Cash	$43.17
Fees for 1926 paid in advance	4.00
Fees from 40 members for 1926	80.00
Fees for 1924	1.00
Fees for 1925	2.00
Grant from General Treasurer	41.00
Interest on Bank Deposits	1.45
	$172.62

DISBURSEMENTS

Paid General Treasurer	$87.00
Printing notices	15.25
Postage, Stationery, exchange	1.15
R. E. Crouch for caretaker	2.00
Cartage on telescope	2.00
Cash balance in Bank	65.22
	$172.62

Audited and found correct,
December 8, 1926.

(Signed) THOS. C. BENSON,
FRED. W. DALY,
Auditors.

WINNIPEG CENTRE
December 15, 1925 to December 15, 1926

RECEIPTS

Balance forward	$223.87
Subscriptions	56.00
Grant, Toronto	21.25
Bank Interest	6.10
	$307.22

EXPENDITURE

To Toronto a/c 1925	42.50
Press notices	30.55
Hire of Lantern	6.00
Printing and Postage	6.50
To Toronto a/c 1926	56.00
Balance on hand	165.67
	$307.22

H. B. ALLAN,
Treasurer.

VICTORIA CENTRE
Revenue and Expenditure, 1926

REVENUE

Collected in subscriptions, 1926	$119.00
Interest from Bank	2.65
From Parent Society	56.50
	$178.15
Balance from 1925	134.98
	$313.13

EXPENDITURE

Remitted to Parent Society		$154.00
Janitor Services	$2.00	
" "	5.00	
" "	6.00	
		13.00
Stamps		.35
Advertising—Times	$1.47	
Colonist	9.98	
Times	21.01	
Colonist	15.56	
		48.02
Card printing		4.90
		$220.27
Balance to 1927		92.86
		$313.13

RECONCILIATION WITH BANK

Balance per Bank Book		$119.86
Less cheque outstanding	$25.00	
Less amount over-deposited	2.00	
		27.00
		$92.86

R. G. MILLER
Treasurer.

Auditor's Certificate.

I hereby certify that I have examined the books of account of the Society for the year 1926, compared same with vouchers and bank book, and I am of the opinion that the above is a true and correct statement of the financial affairs of the Victoria Branch.

H. H. PLASKETT,
Auditor.

PHILADELPHIA MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

By R. Meldrum Stewart

THE thirty-seventh meeting of the American Astronomical Society was held at Philadelphia on December 28 to 30, 1926, in connection with the eighty-third meeting of the American Association for the Advancement of Science; the sessions of the latter body extended throughout the week from December 27 to January 1. The headquarters of the astronomers, as well as of several other associated Societies, were at the Hotel Walton; the meetings were in the various buildings of the University of Pennsylvania.

There were, as usual, meetings of many societies affiliated or associated with the American Association, several of which were of considerable interest to astronomers. Among these may be mentioned Sections A, B and C of the Association, the American Mathematical Society, the Mathematical Association of America, the American Physical Society, the American Meteorological Society and the Eastern Section of the Seismological Society of America.

By special invitation many of the astronomers attended a joint session of Section B and the American Physical Society on Tuesday afternoon, to hear the address of retiring Vice-President H. M. Randall on Infra-red Spectroscopy and a paper by Professor W. F. G. Swann on The New Quantum Dynamics. A joint session with Section D was held on Wednesday afternoon, at which the address of the retiring Vice-President of the Section, Professor A. E. Douglass, on Solar Records in Tree Growths was read. Another joint session, on Cosmic Chemistry, was held on Thursday morning with Section C, at which the following addresses were given—

The Chemistry of the Stars, by Henry Norris Russell.
The Atmosphere, Bottom to Top, by W. J. Humphreys.
The Present Condition of Knowledge on the Composition of Meteorites, by George P. Merrill.

On Wednesday afternoon there was a joint session with the American Association as a whole, at which the speaker was Professor Heber D. Curtis, Director of Allegheny Observatory. Dr. Curtis took for his subject "The Unity of the Universe," and the lecture, which was illustrated by numerous slides, was among the best presented at the meeting; it is to appear in Scientia.

There were, as usual, lectures provided each evening by the American Association, on both popular and technical subjects, and many of these were taken advantage of by astronomers when not employed in special conferences or other engagements. The Science exhibition, held in Weightman Hall, the headquarters of the Association, also deserves special mention.

On Wednesday evening the usual informal dinner of the Society was held in the Hotel Walton, over seventy members and friends being present. Dr. Harlow Shapley acted as toastmaster, and introduced somewhat of an innovation by assigning topics to the various after-dinner speakers called upon; the ingenuity or embarrassment of the speakers in avoiding or twisting to their own purposes these topics added to the enjoyment of the evening. Considerable amusement was caused by the undertaking of astronomer A to eat, course by course, in addition to his own dinner, that of his abstemious confrere B; fortunately for the digestion of A, but unfortunately for the general enjoyment, a belated guest appeared at the last moment and the surplus dinner was requisitioned for him.

On Thursday afternoon, after the close of the last session, many of the astronomers enjoyed a drive through the environs of Philadelphia, visiting en route the Flower and Swarthmore Observatories. At the former, which was exhibited by the acting director, Samuel G. Barton, many regrets were heard that this splendid equipment, which has done such good work in the past, is now, owing to lack of staff, lying practically idle. Before leaving Swarthmore a letter was written and signed by all present, conveying greetings to Professor Miller, together with regrets for his illness and hopes for a speedy recovery.

This terminated the official programme of the Society, but many of the astronomers lingered on to visit the sessions of sister organizations. In addition to the joint addresses mentioned above, 30 papers were presented, 16 on stellar astronomy, 7 on the solar system and 7 on general topics. The papers were as follows:

Dean B. McLaughlin—A Comparison of certain regions of the Milky Way.
F. H. Sears—Some systematic features in the distribution of stars.
Chas. P. Olivier—Systematic errors in double star measures
Alexander Vyssotsky—Note on the double star B.D.+66° 34.
Carl L. Stearns—The Parallax of Alpha Cygni.
S. A. Mitchell—The trigonometric parallax of Mira Ceti.
F. Schlesinger—The Yale station at Johannesburg.
W. S. Adams, A. H. Joy and M. L. Humason—Absolute magnitudes and parallaxes of 410 M-type stars.
Seth B. Nicholson and Hazel Marie Losh—Sun-spot activity in the present cycle.
Otto Struve—On the effect of distance upon the intensities of detached calcium lines.
F. Henroteau—The motion of the Pseudo-Cepheids.
W. E. Harper—Two K-type spectroscopic binaries.
Charles Lane Poor—The relativity deflection of light; the prediction of 1911 and the prediction of 1916.
Walter D. Lambert—The variation of latitude and fluctuations in the motion of the moon.
R. Meldrum Stewart—Canadian work on the international longitude net.
Frederick Slocum—Two telescopes of historic interest.
W. W. Coblentz and C. O. Lampland—Measurements of the radiation from the planet Mars at the Lowell Observatory in 1926.
E. C. Slipher—Photographic and visual observations of Mars in 1926.
John E. Willis—Accurate tables of natural cosines and sines which are easily made and used.
Joel Stebbins—Second report on the light variations of the satellites of Jupiter, and their application to measures of the solar constant.
S. A. Mitchell—The total solar eclipse of June 29, 1927.
William F. Rigge—Occultation of Saturn January 28, 1927.
D. W. Morehouse—A dark ring nebula in Cygnus.
W. W. Coblentz—Note on the water-cell transmissions of the radiation from the star Sirius.
W. W. Coblentz—Tests of a new selective radiometer of molybdenite.
E. Hertzsprung—Relation between period and light curve in Cepheids.
Margaret L. Walton—Spectra and periods of Cepheid variables.
Cecilia H. Payne—Spectrophotometric variations of the brighter Pleiades.
C. T. Elvey—Contour of hydrogen lines in the spectra of Nova Aquilae No. 3.
James Stokley—The cipher of Sir Christopher Wren.

TWO LUNAR HALOS

1. At Haileybury, Ont.

Mr. W. H. Tuke, B.A., Principal of Haileybury High School, writes as follows:

I am enclosing diagrams of halos observed here about 10.30 on Wednesday, February 9. The night was clear, frosty, and windy. There had been auroral displays earlier, and diffuse patches of auroral light were still visible. The features that appeared remarkable to me were:

(1) The larger halo, passing right through the moon. Is this common?

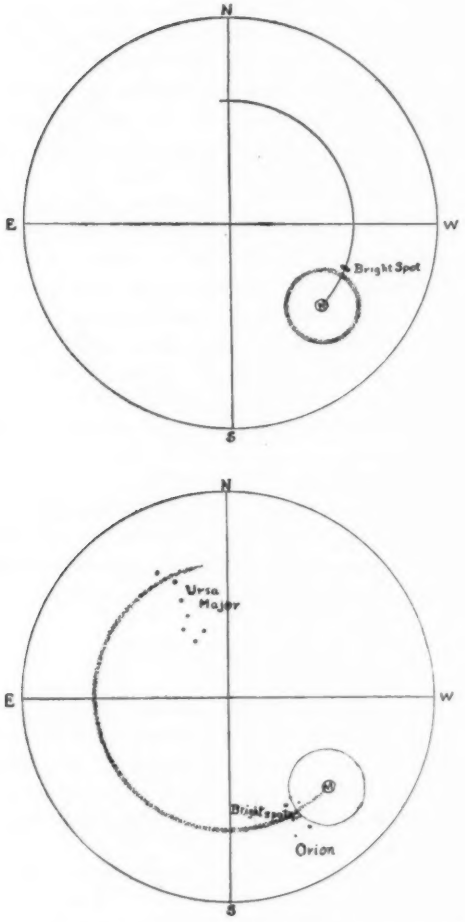
(2) The sky was quite clear, not slightly misty as it usually appears when a halo is seen. The moon, too, was sharply defined. The smaller halo disappeared completely in a few minutes, the larger one a little later. To-day (Thursday) has been clear and at the moment of writing it is cloudless. The barometer is fairly high (743 mm. actual reading). That is, there were not, and are not, any of the usual atmospheric conditions accompanying and following a halo.

(3) Bright patches of light were visible on the large arcs just *outside* where they cut the small halo.

What I am particularly interested in is the question, could the auroral disturbances of the atmosphere produce the halo? I thought that the larger circle was an unusually placed auroral arch at first, but when the other side of it appeared, and the true circular shape became more apparent, I concluded that it was a halo.

Note by A. F. Hunter

The horizontal white circle seen by Mr. Tuke at Haileybury is a rare halo, even in a fractional form. To see one complete, entirely



Lunar Halo seen at Haileybury on February 9, 1927, by W. H. Tuke.

The upper figure shows the appearance when first seen, at about 9.20 p.m.; the lower figure, about 15 minutes later. The small halo had almost disappeared, while the large arc was on the opposite side.

The approximate size of the large circle may be judged from the points at which it cuts Orion and The Dipper.

around the sky, is a very rare occurrence. The height of the thin stratum of cloud (scarcely perceptible from the ground, especially at night) is not known, but the small spicules of snow in the stratum must necessarily have a perpendicular face, as they are acting as small mirrors showing the image of the moon, directly reflected to the observer, none of the light being refracted or coloured.

The observation which Mr. Tuke made, viz., that the cloud stratum causing the halo was travelling rapidly eastward, the large circle having been seen first on the west side, and 15 minutes later on the east side, of the moon, is worthy of a place in the JOURNAL. Not only is the phenomenon rare, but the close observation of it, and the important fact deducible from it, is still rarer.

The auroral phenomena indicate there must have been magnetic disturbance, or activity, at the time. It is at such a time the rare halos are seen, and the observation adds a further example of the coincidence of these conditions, as printed in former items in the JOURNAL.

A report sent by Miss Julia Ford, St. Mary's, Ont., of a brilliant solar halo seen there on the forenoon of September 8, 1926, also indicated a horizontal white circle, complete, as the diagram received seems to show, besides other circles with colours. The halo attained its greatest brilliance about 11 a.m.

2. NEAR VITA, MAN.

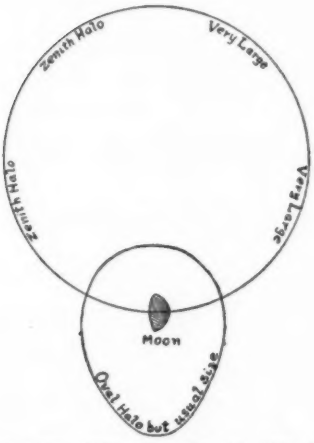
Mr. G. P. Morse, C.E., writes:

The observer was located near International Boundary, south of Vita, Manitoba, on Tuesday, December 14 (when morning temperature showed coldest this winter, approximately 30 below zero, evening temperature about 10 below); lunar halos observed 5 to 5.30 p.m., Central Time.

The moon was a little over half of full phase, not in meridian, but approximately south-east.

One halo was about the usual size but distinctly flattened on top, and drawn down near the horizon, a clear egg-shape.

An intersecting halo passed through the moon's position and was as nearly as could be estimated a perfect zenith circle, being thus very large, complete and distinct; also quite permanent.



Lunar Halo seen near Vita, Man., December 14, 1926, by G. P. Morse.

Nothing in the observer's experience compares with this; and a savage mentality could at once conjure up a "horned devil" to animate this appearance. Sketch attached.

THE NUMBER AND THE DISTANCES OF THE STARS

By C. A. CHANT

Broadcast by CNRT, January 28, 1927

IF I could only see face to face the invisible company now listening to me and could ask each of you how many stars you think there are in the sky, I imagine the general answer would be that there are too many to count. Now what makes you think that?

In the Epistle to the Hebrews, in the New Testament, the children of Israel are compared to "the stars of heaven in multitude and as the sand which is by the sea shore, innumerable".

Shakespeare, in the play Julius Caesar, Act III, Sc. 1, has this line:

"The skies are painted with unnumbered sparks".

Both of these quotations were written before the telescope was invented—the first one many hundred years before—and hence they refer to the sky as seen with the naked eye.

But are the stars numberless? Did these writers state what they *felt* or what they *knew?*

Suppose that on some clear night in the near future you try a little experiment. Choose a definite area of the sky, such as the "Bowl" of the Big Dipper or the Great Square of Pegasus, and count the number of stars which you can see in it. You will be a bit shocked at the few you will find.

Let us try this experiment with Orion, the finest and perhaps the best known of all the constellations. It is well placed for observation these evenings. You all know the three stars in the giant's belt. They are just 1° apart and hence serve well for measurements on the sky. In England they are known as the "Ell and Yard".

We shall take a portion of the sky 8° square, having the Belt at its lowest side and stretching upward to the famous red star Betelgeuse, which is in Orion's right shoulder. In other words, consider the area which covers the upper half of the Giant's body—8° square, 64 square degrees in all.

Now how many stars can be seen in this area? If you are out in the country on a clear moonless night you may see 24. If the full moon is shining, or if you are in the city in the midst of the artificial illumination, you will see only 8—not very many for an area so large.

Some 75 years ago an astronomer named Argelander, living in Bonn, Germany, examined all the stars he could see north of the celestial equator with a telescope 2¾ inches in diameter, and he recorded their positions on forty wonderful charts. In the upper half of Orion he gives 1,440 stars.

With a larger telescope you can see more, and with a long-exposure photograph still more—so many indeed that it is hardly possible to count them.

As a matter of fact the stars in the entire sky which are visible to the naked eye have been carefully counted by more than one astronomer, and the number is about 6,000. It is to be noted, too, that the very faint ones which can just be seen make up about one-quarter of the 6,000.

As we can see only one half of the sky at once it is evident that only about 3,000 stars can be above the horizon at any given time. But the dense atmosphere near the horizon prevents us from seeing the faint stars there. Hence it is doubtful if 2,500 can be seen at any one time, even under the best conditions. In the city perhaps 1,500 is the maximum.

As I have said, about 6,000 stars are within the power of naked eye vision, but an ordinary opera glass will multiply this number about 20 times. The reason is this. The area of the lens of the opera glass is perhaps 15 times the area of the pupil of the eye and hence collects 15 times as much light, and thus fainter stars can be seen.

By using our great telescopes fully 100,000,000 are brought into view, and the camera reveals many more. A few years ago two astronomers at the Royal Observatory at Greenwich in England

made a long and careful study of a new series of photographs covering the sky, in order to see if an intelligent approximation to the total number of the stars could be arrived at. They found definite evidence of the falling off in the numbers of faint stars as one goes farther down the scale of brightness, and they concluded, therefore, that there was a definite limit to the number of stars. They estimated that there are 2,000 millions. That is certainly a very great number, but it is not infinitely great.

Since that time still higher estimates have been made, the latest I have seen, that of Shapley of the Harvard Observatory, in his brilliant little book entitled "Starlight", being 25 times as great, that is, 50,000 million.

It may be interesting for you to know just how many stars are recorded on some of the photographic plates. The Harvard Observatory for nearly 40 years has had a branch in the southern hemisphere in order to study the sky which cannot be seen from our northern latitudes. It has been located on a mountain in Peru, but it will shortly be moved to South Africa, where already three U.S. observatories have southern branches. On one negative 14 inches x 17 inches in size taken in 1922 with an exposure of $6\frac{1}{4}$ hours, a wonderful number of stars with perfectly definite images all over the plate were recorded and an attempt was made to find how many there were. The plate covered more than 45 square degrees of the sky, and by actual count it was found that there were over 61,000 stars per degree, and hence over 2,000,000 on the plate.

Truly the stars of heaven in multitude are as the sands of the sea shore!

Next, let us consider how far the stars are away.

These myriads of stars, you must remember, give out light of their own, and hence are suns. Indeed, our sun is the only one of them near enough to be observed in detail. It is about 93,000,000 miles from the earth. That is a great distance, impossible to visualize. But when we learn that the nearest of the multitude of the starry host is 275,000 times as far off, we are simply lost in the figures. This nearest star is in the constellation The Centaur in the southern celestial hemisphere.

Let us try to express this distance in a more understandable way. You know something about the speed with which light travels. It is simply enormous, and yet it has been measured very accurately. The latest value given by Michelson from his recent experiments on Mt. Wilson in California is 186,284 miles per second in empty space, slightly slower in our atmosphere. This is equivalent to 11 million miles a minute. To come from the sun to the earth, light requires only $8\frac{1}{3}$ minutes. How long do you think it takes to come from that great sun in the Centaur which is our next stellar neighbour?

An hour? No! A day? No! A month? No! A year? No! What, more than a full year? Yes, 4 years and 4 months! And all this time travelling 11 million miles every minute!

If we represent the sun by a ball 1 foot in diameter the earth would be a small pea $\frac{1}{9}$ inch in diameter at a distance of 107 feet while the "near" star in the Centaur would be a ball perhaps a foot and a half in diameter and 5,500 miles away, that is at Pekin or Jerusalem. But remember this is the *nearest* of the fixed stars and there are others a thousand times as far away.

You may wonder how these great stellar distances are determined. At first the same method was employed as is used by the surveyor in finding the distance of a point on the farther side of a river, or of the peak of an inaccessible mountain. He lays out a base-line and carefully measures its length. Then he observes the angles formed with the base-line by the lines drawn from each end to the inaccessible point. From the length of the base and these two angles the distance is easily calculated.

In dealing with the stars the base-line is the diameter of the earth's orbit around the sun, which is 186,000,000 miles long. But measuring the angles is the most difficult job the astronomer has to do.

In more recent times a method has been devised based upon the spectrum of the star, and many star distances have been found in that way. In this work our great observatory at Victoria, B.C., has taken a prominent part, the distances of over 1,000 stars having been determined there.

Still another method has been discovered. It has been found that by observing the variation in the light of some stars it is

possible to say how far they are away. Such stars are called Cepheid variables, so named because the one best known is in the constellation Cepheus. The results obtained with these Cepheid variables are simply astounding. In the sky there are what are known as clusters of stars. The famous group called the Pleiades is a loose or open cluster; Praesepe (or the Beehive) in Cancer is a closer one; while others are composed of thousands of stars apparently packed together into a ball. They are known as globular clusters, and one of the very finest is in the constellation of Hercules. To the naked eye it looks like a faint hazy star, but in a large telescope it is a mass of sparkling jewels. Once seen, never forgotten. With a long exposure photograph it is a most striking object which can be studied at leisure and compared with other photographs to see if any change has taken place.

Now these clusters are full of Cepheid variables and from them the distances of the clusters can be estimated. The two nearest are in the southern sky. They are approximately 20,000 light years distant. The great cluster in Hercules is 36,000 light years away; while the distances of the more remote exceed 100,000 light years.

Finally, exercise your imagination and try to picture to yourself our universe. We live on the earth, which is a member of a family of planets circling about the sun. We travel at the rate of $18\frac{1}{2}$ miles a second while the other planets move, some faster, some slower. Most of the planets have moons revolving about them, and usually there are several comets within the limits of the solar system. But the system seems to be entirely by itself, isolated in space; while in all directions, but at almost infinite distances are the stars, the nebulae and other members of the celestial stellar company.

It is a wonderful universe!

THE INFINITELY GREAT AND THE INFINITELY SMALL

By E. F. Burton

Broadcast by CNRT, February 11, 1927

WHEN this talk was first planned I had intended to treat with equal fullness the limits of the great distances and the small distances which the scientist has to measure to-day. However, recently you have had a talk by Dr. Chant on the number and distances of the stars, in which you had impressed upon you the enormous distances with which astronomers have to deal, so that with regard to the infinitely great I shall merely recall to you some of the distances then brought to your attention.

Our appreciation of distances changes with our changing experience: as small boys trudging over a mile or so to school along a country road, a mile used to seem a mighty distance: as we grow older and steam across the prairies of our West or plough through the ocean day after day and night after night, we have borne in upon us some conception of a thousand miles; the advent of the airplane and the circling of the globe in an almost unbroken trip encourages us to speak lightly of a matter of twenty thousand miles. But here our conscious experience of distance ends. We have to use our imagination to picture the distances with which we have to deal when we talk of our own solar system. The distance to the moon—240,000 miles—is a mere step when compared to the distance of the sun from the earth—roughly, 93,000,000 miles. If we should sit down to calculate how long it would take us to count to one million, we could get some glimmering of what such a number as even one million means. Counting at the rate of 100 per minute without break until we reach a million it would take a whole week, day and night, to complete the count.

Our solar system consisting of the sun as centre and her seven planets (not counting the earth) is a mere speck in the universe and yet the distance from the sun to the outermost planet Neptune

When we call the microscope to our aid another world of small things is displayed as for example the dimensions of:

The largest disease germs, that of relapsing fever, 16/10,000 inch.
Red blood corpuscles 3/10,000 inch.
Typhoid bacilli (rods) 3/100,000 by 12/100,000 inch.
Streptococci germs of blood poisoning are chains of individuals each measuring 2/100,000 inch in diameter.
Influenza bacilli are oblong bodies 2/100,000 by 8/1,000,000 inch.

These bacilli bring us to the limit of the highest power of the microscope, which enables us to see a particle 1/100,000 inch in diameter, but no smaller. Some idea of the minuteness of the influenza bacillus may be gathered from the fact that we could pack into a robin's egg 10^{16} influenza bacilli which would, if distributed over the earth's surface, provide 5 million for every living being.

A few years ago 1/100,000 of an inch would have been fixed as the limit of things visible to man. The invention of the ultramicroscope has pushed this limit still farther. The so-called ultramicroscope is simply a new method of illumination used with an ordinary microscope and is in reality an application of a very commonplace experience. We all know that if we are in a darkened room and a beam of sunlight is sent across the room we are made aware of the presence of thousands of motes and dust particles in the atmosphere, which are quite unseen by us when the room is very brightly illuminated throughout. We see these small particles because of the light which they scatter into the dark parts of the room. If we call in the aid of a microscope to view these particles we can see still more of them. By this device scientists have been able to see individual particles 4/10,000,000 inch in diameter. It was by this means that the discovery of cancer germs announced by Drs. Barnard and Gye in England a year or so ago, was made.

As we shall be dealing with still smaller dimensions I should like to revert to the shorthand notation brought to your attention a few minutes ago. We are in the practice of writing fractions in this way: one-tenth, *i.e.*, 1/10 is written 10 with a -1 above it and is called 10^{-1}: so 1/100 is 10^{-2}; and so on. To recapitulate some of the sizes I have given we have

House-fly egg, 4×10^{-2} inch.
Limit of naked eye, 4×10^{-3} inch.
Oyster egg, 2×10^{-3} inch.
Red corpuscles, 3×10^{-4} inch.
Influenza bacillus, 2×10^{-5} to 8×10^{-6} inch.
Microscope limit, 1×10^{-5} inch.
Ultramicroscope limit, 4×10^{-7} inch.

This brings me to the limit of things which we can see but by no means to the smallest thing which we can prove exists. It is pretty common knowledge now that we look upon all material bodies as being made up of discrete particles—the so-called molecules. What is the size of a molecule? Time will permit me to answer this merely by giving an example or two. I refer to experiments on measuring the thickness of films—(1) of soap films, (2) of oil films on the surface of water. The thinnest soap film that has ever been measured is about $2 < 10^{-7}$ inch in thickness while much thinner films of oil on water have been used by the late Lord Rayleigh. A very small drop of oil of known weight was dropped on a very large surface of clean water and the area over which it spread was determined. It is apparent that if the total volume of the oil is known and the area of the sheet of oil is determined, one can easily determine the thickness of the oil film. This Rayleigh did and obtained as the smallest thickness $5 < 10^{-8}$ inch. Now this layer of oil on water must be at least one molecule thick and so we have an approximation to the size of a molecule of oil. Many other methods equally as convincing are available to determine the diameters of molecules of various substances. The smallest molecules we know, hydrogen and helium, are about 10^{-8} inches, *i.e.*, one-one hundred millionth of an inch.

If molecules are as small as I have indicated there must be enormous numbers of them in a comparatively small volume. To obtain some idea of this great number, the following illustration is helpful. If you draw off a glass of water from a tap in your house and could take it out to the middle of the Atlantic, throw it in and allow time for that water to be evenly distributed throughout all the oceans, lakes and rivers of the earth, and then return to the same tap and draw off another glassful, you would draw

off this second time 2,000 of the original molecules. This means that the number of water molecules in one glass of water is so great that if they were evenly distributed through all the water on the face of the earth they would be scattered at the rate of 2,000 for every glassful. If a drop of water were magnified to the size of the earth, the molecules would be the size of footballs.

If we had been speaking thirty years ago we should have stopped here. About that time there was established in our language the word electron—a term for "the fourth state of matter" first suggested by Sir William Crookes. He showed that if a glass tube be constructed so that an electric discharge can be passed through it from wires sealed in each end, and if the gas be almost completely removed from the tube, rays of matter in a peculiar state pass through the tube during the discharge and render the glass phosphorescent: this state of matter is neither solid, liquid nor gas because these rays can come freely through a very thin window through which the smallest gas molecule cannot pass. It has been shown beyond a doubt that these rays consist of particles, similar to matter, which bear a negative charge of electricity but are only 1/2000 the mass of an atom of hydrogen. I certainly do not need to say anything to convince you of the real existence of electrons because the very tubes which you have in your receiving sets do their work through the hot filament giving off all the time a copious supply of these very electrons, a supply which makes radio possible.

Nevertheless when we come to deal with electrons we do enter the realm of speculation. The fact that all kinds of matter give off electrons of exactly the same nature, shows us that the electron is a common constituent of all matter and we have reason to believe that it is nothing but negative electricity. Speculation as to its size gives the value about 10^{-13} inches—a diameter only 1/100,000 of that of the smallest molecule.

Since our study of electricity shows us that all matter has positive as well as negative electricity, the efforts of many physicists in recent years have been directed toward isolating the unit of positive charge. This has been found and named the *proton*. In fact we now believe that matter is just positive and negative electricity—whatever that may be—and every atom of every

element is like a very minute solar system having a central nucleus or sun made up of protons and electrons and outer planets which are electrons revolving at enormous rates about the centre. The proton is much smaller than the electron, having a suggested diameter only 1/1,000 of that of the electron. So we have arrived at the conception of a small distance 10^{-16} (1/10,000,000,000,000,000) inches, quite as far beyond our human comprehension as was the limit of great distances 10^{19} (10,000,000,000,000,000,000) inches. One of the most stupendous generalizations of all time is that in these minute atomic systems we have the same gravitational law holding as that which regulates the motion of the planets about our sun, and for all we know the whole of our known universe. Whether we contemplate the infinitely small or the infinitely large we encounter the same quest "What is beyond?" and end in theories and speculation. "But none of our theories are quite large enough for all the disclosures of time."

University of Toronto.

"OUR MOBILE EARTH" By Reginald A. Daly*

Reviewed by Ernest A. Hodgson

IN "Our Mobile Earth", Professor Daly attempts to present (within the space of one volume) a continuous cosmogony and geology (not forgetting seismology and volcanology) which shall be ever in agreement with the facts of these sciences, if not always conforming to the alternative theories of some of his fellow scientists. Further, he has essayed the task of making the book intelligible and inviting to the general, non-technical reader. He has notably succeeded in his difficult task.

In his preface he points out the reason for a somewhat dogmatic presentation of material which must be considered speculative; but, by means of which, the "bewildering flood" of facts and hypotheses may be synthesized. In no other way could he have retained the interest of his readers and accomplished his purpose of orderly presentation of the subject. The preface should be carefully scanned before the text is attacked, and again after the whole has been read. By means of the preface, and by many interpolated words of warning, scattered through the book, Professor Daly prevents the possibility of the general reader mistaking the relative status of fact and theory. On page 291 he points out (speaking of the theory of mountain building): "Throughout this whole discussion the reader will remember that speculation is not science or knowledge. Speculation, even of the happiest kind, can do no more than point the way to possible future knowledge."

The book is profusely illustrated. A total of 187 figures, half tones and line cuts, are distributed throughout its 320 pages of text. The value of the illustrations is not measured by their number—great though it is. References to many of them occur at more than one position in the book; each different point of view requiring a different emphasis in directing our regard of the dia-

*_Our Mobile Earth_, by Reginald A. Daly, pages xxii + 342, 9 × 6 in., bibliography and index. N.Y. Scribners, 1926. Price $5.

grams and pictures. An appendix gives an exceptionally valuable index, bringing the total pagination up to 342.

The style of the book, though popular, does not hesitate to use technical terms where these can express ideas clearly and concisely to the average reader. In each case these are first used in a context, which makes quite clear exactly what is meant. In this way one adds painlessly to his vocabulary such words as dyke, shield, basement complex, laccolith, batholith, geosyncline, anticline, beach (in an extended sense), basalt, isostasy, and many others.

The English is clear and forceful. Short sentences predominate. Rhetorical questions receive immediate and satisfactory answers. Startling facts are presented in a manner which serves to drive them home and fix them in the mind of the reader. Thus we are told (speaking of the absence of fault scarps in the eastern United States): "Now, not a single long clifflet of the kind, clearly due to sudden rupture and displacement of the rocks during the last 5,000 or 10,000 years, is known in the United States east of the Mississippi River. To the geologist, therefore, no other reason is needed to make him sceptical of forecasts of very serious damage to New York, Boston, or any other Eastern city of the United States." And again (speaking of the absence of granite in the floor of the Pacific), he says: "Particularly, not a cubic inch of granite rock has ever been found in the hundreds of volcanic islands which dot the region of the central Pacific, one fourth of the area of the whole globe. So far as they go, these facts suggest that the suboceanic crust is composed of rocks decidedly different from the rocks constituting the continents." Other examples might be quoted. These devices, coupled with a clear, direct argument from the known to the unknown, from the simple to the complex, from fact to theory, sustain the interest while an astonishingly great amount of scientific fact and theory is being critically examined.

The plan of the book is simple. Beginning with the evidences of mobility most generally known—earthquakes—he studies the subject of their nature and cause, proceeding then to speculate on the interior of the earth as revealed by a study of their records. This leads naturally to a consideration of magma, of volcanic action, and of the various ways in which the intrusions of magma

make the crust of the earth mobile. The evidence of changes of level over large areas and their possible causes then leads to speculation as to the probable results of changes in level presumed to have occurred in the earth's crust in earliest geologic times. The theory of mountain building, by "landslides" of whole continents over a basaltic substratum, is explained and expanded in an attempt to show why the early differences in level first appeared.

Having set out the entire theory in a progressive argument with as much illustration as the space available could warrant, Professor Daly gives a summary, prefaced with these sentences: "Now let us run quickly through the history of the globe since its primitive single continent was completed. For simplicity of statement, a rigorous distinction between the ascertained facts of geology and many speculative considerations of the foregoing chapters will not be made. The reader himself has already savoured the uncertainty which must attend any effort to sketch the earth's development. He may be able once more to forgive apparent dogmatism in the description." There follows (within the space of about 1,500 words) a complete and ordered exposition of his cosmogony and cosmology, dogmatically set forth without the circumlocution of argument and proof which marked his progress through the volume. It forms a fitting close to a well planned treatise.

The first chapter (pp. 1-44) deals with "Great Earthquakes of History". Throughout these pages Professor Daly emphasizes the serious nature of the great earth shocks from the Lisbon quake of 1755 to the Tokyo shock of 1923; from the Charleston disaster, involving a loss of 27 lives, to the Kansu tremblor where "the mountains walked in the night", resulting in the death of nearly 200,000. He points out, however, that Mallet's estimate of deaths from earthquakes during 4,000 years is about 13,000,000—"only about one-sixth of the rate at which the automobile is destroying lives in the United States alone."

He then shows the first interesting scientific fact brought out by a study of these earthquakes, namely, that their epicentres, or positions of maximum damage, are limited to certain definite locations on the earth. While shocks of moderate intensity may, and do, occur in almost all parts of the world, the major shocks

are, as a rule, confined to regions which are marked by visible mountains or by submarine mountain chains, *i.e.*, where differences in *ground* level are most pronounced, whether these are in evidence, or are covered by the sea. This fact assumes significance where we are introduced to the theory of mountain building in chapter VII.

He examines, somewhat in detail, the seismicity of the United States, giving a table of the number of shocks felt in each state from 1915 to 1923 inclusive. It may interest those not concerned with a study of seismology to note that the earthquakes of 1925 are not unique. In 1915, for example, an earthquake in Nevada opened cracks 22 miles long and formed a scarp, at places 15 feet high.

Professor Daly stresses the importance of taking advantage of what has been learned of earthquake action for the preservation of human life. This may be done by imposing suitable restrictions in building codes, by locating buildings away from alluvium, and by the education of those living in earthquake regions.

At this point I may say that Professor Daly claims that *deep* alluvium absorbs seismic waves and reduces the probability of damage to structures built thereon (page 13). Most, if not all, seismologists would, I think, take issue with him on this statement. So far as I know, deep alluvium is quite as treacherous as shallow alluvium. All such areas should be avoided in choosing building sites in seismic areas.

The phenomena attending earthquakes and the geological evidences presented by a field study of their effects are set forth in preparation for the discussion of the second chapter (pp. 45-89) dealing with "The Nature of Earthquakes".

The nature of earthquakes, volcanic, tectonic and impact, are explained, special emphasis being placed on the tectonic shocks. The evidence of fault scarps and horizontal shifts is presented by means of many diagrams and half tones, depicting the effects of various earthquakes in different parts of the world. The tectonic earthquake is shown to be due to the sudden shifting of blocks of the earth's crust when the rigidity of that crust fails under a steadily increasing strain.

The seismograph is described and a well selected and typical seismogram shown (page 86). It is unfortunate, however, that

such an inadequate description of so important an instrument should be given. One must recognize, of course, that in a book of this kind the author cannot permit the discussion (and the interest of his readers) to drift up a side channel. But the description as given is somewhat misleading and quite incomplete. Within the same space and making use of but one more diagram or half tone, a better idea of the instrument might be conveyed with advantage.

The importance of the seismic waves is touched on in this chapter (to be dealt with more fully in the next.) From a study of them we are led to deduce that the centre of the earth is composed of material, very different from that near the snrface, homogeneous and symmetrical (a sphere), which from other considerations we deduce to be very dense. We also receive confirmation of the hypothesis that the crust of the earth is rather thin—of the order of forty miles—and that it rests on a substratum of quite different material, the two being separated by a surface of discontinuity. These discussions lead us to the next chapter (pp. 90-127) where we study "The Earth's Interior".

The chapter begins with a page or more of rhetorical questions, serving to introduce as many geological facts requiring explanation. The balance of the chapter is given over to an explanation of these facts. The hypothesis of a substratum of basalt is adopted. This substratum is supposedly overlain by a crust "about forty miles thick", composed of crystalline rocks. These rocks are classed as igneous, sedimentary, and metamorphic. The evidence is presented supporting the conclusions that, (1) the average "density" (specific gravity) of the granitic crust is 2.7, (2) the density of the basaltic substratum varies from 2.85 at the bottom of the crust to 3.0 at a depth of 100-150 miles, (3) the density of the earth increases until the specific gravity of the central core is 11.6.

The evidence is classified under the headings, (1) the earth's mean density, (2) the shape of sea level, (3) the precession of the equinoxes, (4) the tidal disruption theory, (5) the compressibility of matter, (6) the evidence of meteors that iron is "the world-stuff from which planets are made." This is followed by a brief and orderly setting forth of the present accepted ideas as to the various layers of the earth's interior.

The question of internal temperatures is next taken up and many interesting data are given as to temperatures in deep wells and bore holes, the evidence tending to indicate a temperature of 1,300 degrees Centigrade at the bottom of the crust.

The discussion of isostasy occupies most of the remaining space of this chapter; the evidence of seismic waves from near earthquakes as to the depth of the outer crust is also discussed. The chapter leaves one with the feeling that an eruption of the hot basaltic substratum would be the inevitable result of a deep fracture of the floating crust. We are thus prepared for the next chapter (pp. 128-169) on "Volcanic Action."

Volcanoes are first classed as cone, fissure, and areal in type; and the evidence is presented for believing these to be rather superficial distinctions. The principal of gas fluxing is called upon to explain the phenomena of volcanic eruptions. The chapter is an intensely interesting one. The theories serve admirably to maintain the interest of the reader. The story of the explosion of Bandai-San is, indeed, dramatic. A consideration of sills and laccoliths introduces the idea of regional distortion. Changes of level on a larger scale form the topic of the next chapter (pp. 170-210) with the title "Changes of Level. Distortions of the Earth."

The chapter presents the evidences of repeated submergence and elevation of much of the earth's surface. The rather bewildering array of facts is systematized when one considers them under the headings of ice fields, erosion, etc. Prof. Daly's explanation of the down-warping and subsequent re-elevation of areas because of the deposit and removal of ice sheets on the one hand, and because of the piling up and subsequent heating of sedimentary deposits on the other, prepares one for his theory of mountain building. This is reserved for the sixth chapter (pp. 211-250) on "Mountain Ranges" and for the seventh chapter (pp. 251-291) on "Origin of Mountain Ranges."

The first of these chapters deals with the conditions as found to exist at present: sedimentary rocks at high elevations, greatly deformed layers as found in mountains, geosynclines and geoanticlines, the great rock "shields" of ancient "basement complex", the distribution and the festoon arrangement of mountain ranges.

The second chapter attempts to explain these conditions as due to "landslides" of whole continents which have slid by reason of horizontal tensions generated by the deposition of sediments in the geosynclines in midlatitudes and on the edges of the, one-time, single continent as postulated by Taylor and Wegener. These landslides, according to the author, have slowly broken up and rafted together the granitic crust at the point of loading until it has attained great thickness, being pressed down into the hot basalt below. This submerged mass of twisted and deformed strata, being heated, has expanded, its density has become less, and it now floats higher, thus forming the mountain ranges.

The next chapter (pp. 292-320) considers the "Evolution of the Face of the Earth", in the light of the theories already presented. In particular the later history of the Connecticut Valley region, as explained by the late Joseph Barrell of Yale, is described in detail, illustrated by a series of eight diagrams.

The tidal disruption theory of the origin of the earth as proposed by Chamberlin and modified by Jeans and Jeffreys is explained; the theories of Henri Poicaré and George H. Darwin as to the origin of the moon are discussed; all of these in an attempt to offer some explanation of the genesis of the first single continent as required in the mountain building hypothesis.

A brief discussion of the age of the earth gives a basis for a time scale which is at once used in the direct summary of the entire argument of the book, covering pages 315 to 320 inclusive.

The book concludes, with an appendix of suggested works of reference, arranged chapter by chapter (pp. 321-326), and with a very complete index (pp. 327-342).

Though one may disagree with Prof. Daly in regard to some of his theories, it must be granted that "Our Mobile Earth" is a veritable mine of accurate geological facts; and that the theories presented serve to arrange the facts in logical order and to make the book most interesting as well as informative to a wide range of readers.

Dominion Observatory,
Ottawa.
February 25, 1927.

REVIEW OF PUBLICATIONS

Astronomy, by Henry Norris Russell, Raymond Smith Dugan and John Quincy Stewart (A revision of Young's "Manual of Astronomy"). Vol. I, The Solar System; Vol. II, Astrophysics and Stellar Astronomy, 1008 pages in all, $5\frac{1}{2}$ $8\frac{3}{4}$ in. Ginn and Co., 1926, 1927. Price $2.48 per volume.

Young's "Manual" has long been considered the best of text-books, and as it had become greatly out of date, the revision of it has been looked forward to with much interest.

The first volume was published last autumn and the second is now ready. An increase of almost 400 pages has led to the work being put forth in two parts, though the numbering of the chapters and of the pages is continuous. Vol. I deals with the Solar System; Vol. II with Astrophysics and Stellar Astronomy.

Any one familiar with the "Manual" will recognize many portions of it in the first volume, but it has all been re-cast and re-written and the changes are so numerous and the additions so large that it is really a new work. It was fitting that Young's successors at Princeton should produce the new Astronomy and they have laid the astronomical world under a great obligation by the capable way in which their work has been done.

The matter in the first volume (relating to the Solar System) did not call for revolutionary changes, but nevertheless there has been extensive revision and the incorporation of late information. The alterations, on the whole, are improvements and give newness and freshness to the treatment. Much is included but the present writer would have added a few other things. In the case of refraction the method of obtaining the simple approximate formula would have given definiteness to the qualitative reasoning. Also the manner of obtaining the formula for the dip of the horizon might have been added in small type. The treatment of the mass

of the moon is pretty hard for elementary students. The addition of some numerical values in the text and fuller reference to the excellent diagram (Fig. 74) would have added definiteness to the explanation. After all, however, these are matters on which judgments may differ.

Attention may be drawn to Von Jolly's method of finding the mass of the earth which is lucidly explained and illustrated by a numerical exercise. The clear and explicit instructions regarding units throughout are commendable. The paragraphs on the constitution of the earth's interior and the age of the earth give some of the latest views and are full of information, though rather condensed. Indeed the same may be said about numerous other topics.

Some of the cuts are not quite so pleasing as those in the original edition. Among these may be mentioned Figs. 65, 68, 111, 112, 125. They are too "machine-made" and compare unfavourably with the artistic drawings in the old book. There are many interesting photographs reproduced (though the blocks might be improved in some cases), among them being the charming picture of the midnight sun by MacMillan (Fig. 67).

The chapter on Celestial Mechanics contains matter of a higher order of difficulty than the other parts of the book. Some of it might have been omitted or relegated to fine print.

In the chapters on the planets the physical conditions are discussed in an able and interesting manner. The latest information regarding the rotation of Venus is given, the conclusion being that this planet does not rotate in a short period but does not always present the same face to the sun.

The twenty-two pages devoted to Mars contain an admirable presentation of recent investigations and observations. They show very clearly the decided change in the attitude of astronomers upon this subject which has taken place in recent years. Lowell would feel quite familiar with the present-day interpretations of his work. Late researches at the Lowell, Lick and Mount Wilson observatories have given a reality to the atmospheric conditions and to the surface markings and their significance, which has brought new life into the study of the planet. The general views of Lowell and W. H. Pickering seem quite reasonable and probable. A still further improvement in instrumental equipment may at the

next close opposition give even more definite evidence as to the conditions on the surface.

Information regarding the asteroids is brought up to 1924. It is all interesting, but some of the sections (for instance, 419) might well be put in small type. Indeed all through the book a judicious use of small type for the more detailed but less essential paragraphs would be an advantage.

Following the old edition, it is stated (page 347) that Piazzi discovered Ceres on January 1, 1801, and that it was re-discovered at the end of the next year, *i.e.*, 1802. Moulton in his "Introduction to Astronomy" seems to say the same thing. However A. M. Clerke in "History", 4th ed., p. 74, and R. Grant in "History of Physical Astronomy", p. 238, say it was re-discovered by Von Zach on December 31, 1801, and by Olbers on the following evening, one year after its original discovery.

The second volume is devoted to Astrophysics and the Stars, and here the greatest changes are seen. Indeed an entirely new treatise has been prepared. Most of the material in it has been produced since the old "Manual" was written. In no book with which the writer is acquainted is to be found such a comprehensive, though condensed, treatment of not the New Astronomy, but the New Astrophysics. As the authors say:

> Astrophysics, or the "new astronomy", began in the latter half of the nineteenth century with the employment of the spectroscope and photometer for astronomical observations. The data obtained by the new methods, however, remained but partially interpreted until very recent years. Many of these data, in particular the spectroscopic, involve the behaviour of atoms in the stars, and interpretation has waited for the development, by physicists and chemists, of a theory of the nature of matter capable of explaining the behaviour of atoms in the laboratory.
>
> We are still far from a complete theory of atomic structure, but much is already known, and application of the new principles to astrophysical matters is leading to results of great interest in astronomy. Here is the most active frontier of the science, where discoveries of importance are continually being made. On that very account the new astrophysics is with difficulty described in a text-book: it is still in a state of flux, and conclusions which to-day are thought to be well substantiated may be overthrown to-morrow (page 548).

As this portion of the new work is so different it may be well to give a brief statement of its contents. The volume opens with

Chapter XIV (24 pages) on "The Analysis of Light", in which all the essential terms and the new methods employed are explained. Here we have condensed but clear explanation of wave-length, radiation pressure, polarisation, units of light, and so on.

The next two chapters (53 pages) deal with the Solar System and the sun's light and heat. In them we are introduced to Stefan's Law, Wien's Law, Planck's Formula, the theory of planetary temperatures and many other thoroughly modern topics.

Then follows a chapter on "Atomic Theory and Astrophysics" (45 pages), in which the sub-divisions are: Theory of Atomic Structure, Origin of Spectra, Applications to Solar Physics, Conditions inside the Sun. It is shown how the latest developments in atomic physics have their most striking applications to the heavenly bodies.

Chapter XVIII (52 pages) is entitled "The Stars". In it the following topics are discussed: Nature and Number of the Stars, Stellar Spectra, Brightness of the Stars, Motions and Distances of the Stars.

Chapter XIX (32 pages) takes up in detail the motions of the stars, including proper motion and radial velocity; also absolute, magnitude, preferential motion, mean parallax, and other modern topics.

The next chapter (46 pages) is entitled "Double Stars". It discusses visual double stars, spectroscopic binaries and eclipsing binaries; and, as in other cases, the latest results, such as the relation between mass and absolute magnitude, are taken up. It was surely an oversight not to include a photograph of the spectrum of one or two binaries. Such are familiar, but not to elementary students.

In chapter XXI (31 pages) the luminosities, temperatures and diameters of the stars are dealt with; and included are the following interesting topics: Absolute Magnitudes and Spectra, Stellar Temperatures, Stellar Diameters. It need hardly be said that the matter in this chapter is very modern.

Chapter XXII (36 pages) is entitled "Variable Stars". After a historic note and general introduction the following topics are discussed: Periodic Variables (including the theory of Cepheids), Irregular Variables, and Novae.

Chapter XXIII (27 pages) deals with Star Clusters and the Milky Way and discusses some of the notable work of Shapley and Hubble.

The Nebulae are taken up in chapter XXIV (42 pages). Nebulae within and without the Galaxy are discussed—their various types, their distances, dimensions and motions, and the cause of their luminosity. The last section deals with "Island Universes".

Chapter XXV (43 pages) deals with the "Constitution of the Stars". Its special topics are (*a*) the atmosphere of a star, and (*b*) the interior of a star. Many of the outstanding problems connected with the temperature, pressure, colours, giants, dwarfs, etc., are discussed. At the end are given proofs of some of the formulae used—developed too recently to have been included in a previous text-book.

The final chapter (31 pages) is entitled "The Evolution of the Stars". Among the topics discussed are the source of stellar energy, thermal stability, theories of stellar evolution, life history of a star, plurality of worlds, the possible fate of the universe.

The concluding paragraphs are as follows:

> The fate of the physical universe, so far as the scientific imagination enables us to follow it, rests upon the answer to this unsolved riddle. If the radiant energy flies on forever, spreading out into infinite space, then all the available energy of the universe (including that liberated by the annihilation of most of the matter which was once present in it) must ultimately be lost in this bottomless abyss, and the end will be darkness and stagnation. If, in some way still unknown to us, matter is formed again out of the radiant energy, a vast process of unending change may go on forever. What we know so far exhibits the processes of nature as irreversible; but our knowledge of nature is limited, and any answer to questions of such scope as this must at present be purely speculative.
>
> It may be that at the last the dissipation will be complete, and the end will come with "darkness upon the face of the deep", or, instead, that in some way there may arise "a new heaven and a new earth", perpetually renewed; but which hypothesis is true our present science cannot tell.

The many abstruse and speculative problems are handled with a deftness and assurance of touch which calls forth the admiration of the reader.

As will be seen, the second volume covers a wide field, much

of which has only recently been brought under cultivation. The very comprehensiveness of the work raises difficulties as to the use of the book by elementary classes. Perhaps from the rich profusion of gifts which are offered, enough can be selected to make a suitable course. It is certainly impossible to find in any other book the material so well digested and clearly presented.

Mention should be made of the Tables, thirty-nine in number throughout the book—a veritable treasury of the latest results. As examples: No. 4, Principal Elements of the Solar System; 9. Planetary Temperatures; 14. The Brightest Stars; 30. The Temperatures of the Stars; 39. Physical Constants of Astrophysical Significance.

Mechanically the book is well produced (though possibly a few of the half-tones might be improved) and the price is certainly reasonable.

C. A. CHANT.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Columbia University Observatory

To provide suitable facilities for the teaching of astronomy in a university which is in the midst of a great city is not an easy task, and general interest will be shown in the method followed at Columbia University in New York City. Here new Physics Laboratories have been erected at 120th Street east of Broadway. The building is 183 feet long and 63 feet wide and contains 14 floors. The Department of Astronomy is housed on the thirteenth floor and the astronomical observatory is on the roof of the building. It includes a 12-inch telescope with a Clark objective, and a transit house. The floor of the main observatory may be raised or lowered at will, obviating the use of steps and facilitating the instruction of large classes in observational work.

Discovery of the Planet Uranus

The planet Uranus was discovered by William Herschel at Bath on March 13, 1781. Alfred Noyes in "Watchers of the Skies" makes Herschel speak thus:

> That marvellous night
> When—ah, how difficult it will be to guide,
> With all these wonders whirling through my brain!—
> After a Pump-room concert I came home
> Hot-foot, out of the fluttering sea of fans,
> Coquelicot-ribboned belles and periwigged beaux,
> To my Newtonian telescope.
> The design
> Was his; but more than half the joy my own,
> Because it was the work of my own hand,
> A new one, with an eye six inches wide,
> Better than even the best that Newton made.

Then, as I turned it on the Gemini,
And the deep stillness of those constant lights,
Castor and Pollux, lucid pilot-stars,
Began to calm the fever of my blood,
I saw, O, first of all mankind I saw
The disk of my new planet gliding there
Beyond our tumults, in that realm of peace.

It may be remarked that the actual observation was made between 10 and 11 in the evening of the above date. Did Herschel conduct a Pump-room concert that evening?

How Big is the Moon?

Answers by three women college students: As big as (1) a desert plate, (2) a "quarter", (3) a dinner plate.

By a theological professor: As big as a good-sized round dinner table.

Newton died on March 20, 1727

The bi-centenary of the death of Sir Isaac Newton is being commemorated this year. It may not be inappropriate to quote the opening and the closing lines of that portion devoted to Newton in "The Torch-bearers" by Alfred Noyes.

"If I saw farther, 'twas because I stood
On giant shoulders," wrote the king of thought,
Too proud of his great line to slight the toils
Of his forebears.

. . . . . .

"I know not how my work may seem to others—"
So wrote our mightiest mind—"But to myself
I seem a child that, wandering all day long
Upon the sea-shore, gathers here a shell,
And there a pebble, coloured by the wave,
While the great ocean of truth, from sky to sky,
Stretches before him, boundless, unexplored."

He has explored it now, and needs of me
Neither defence nor tribute. His own work
Remains his monument. He rose at last so near
The Power divine that none can nearer go;
None in this age! To carry on his fire
We must await a mightier age to come.

C.A.C.

MEETINGS OF THE SOCIETY

AT LONDON

The December meeting of the Society took the form of a complimentary banquet to the President, Dr. H. R. Kingston and the Secretary-Treasurer, Dr. E. T. White and their wives. Under the capable management of the vice-president, Mrs. W. E. Saunders, the banquet was a decided success. The main address was given by Rev. R. J. Bowen, F.R.G.S., on the "Yukon". Mr. Bowen gave in a very happy way an account of his trip from the old land to America, then across the continent and up the coast to the Klondike. He gave a vivid picture of the wonderful beauty of the heavens as seen in that northern latitude —the dome of the heavens so clear, so majestic and seemingly so close? He contrasted the magnificence of a northern winter evening with the murky atmosphere of old London or Manchester. He then went on to tell of mock suns, the wonderful display of meteors and the beauty of the aurora borealis. He pointed out that the sun is at times visible for the full twenty-four hours, and brought to our attention the long twilight of midwinter and the perpetual light of midsummer. The following interesting information was given concerning conditions at that point in the Klondike whose co-ordinates are: latitude 60° 3′ 22.85″ N., altitude 1,200 ft., longitude 9h. 17 min. 43.896 sec. In the course of the year there were 3,530 hours sunshine, 2,479 hours twilight, 1,917 hours darkness, 834 hours moonlight.

E. T. WHITE, *Secretary.*

AT MONTREAL

In the Macdonald Physics Building, January 13, 1927; the President, Col. W. E. Lyman, in the chair.

The election of new members took place as follows: Professor H. F. Armstrong, Dr. F. R. England, Dr. C. C. Birchard, Mr. P. H. Theberge, Mr. Chas. M. Cotton, Mr. A. Press, Mrs. M. Petzold.

The President called upon Dr. L. V. King to introduce the speaker as many non-members of the Society were present. The Hon. President, Monseigneur C. P. Choquette, then addressed the society in French by special request, his subject being "Dettes Mutuelles de l'Astronomie et de la Physique." The following is a summary of his address which the lecturer very kindly furnished.

"Young people in France seem to have more opportunity than in our country to learn astronomy and the allied sciences. In some villages we see on the public square a marble pillar bearing a sun-dial at the top and on the sides we read the latitude, the longitude, the altitude above sea level of the place. A

barometer is also seen with the barometric lines of the day. In a church, in Paris, can be seen a fine meridian line that terminates, on the winter solstice, at the forehead of the statue of Cassini. It belongs to our Society to look for the erection of such monuments along our roads and on our public places.

By the determination of the velocity of light astronomy made to the scientific world at large a most important gift. Both Fresnel and Clerk-Maxwell profited immensely by this knowledge for the elaboration of their respective theories. The physicists expect that Michelson, following Foucault, will pay a fraction of their debt by solving the same problem, with a much greater precision by terrestrial measures. This will give, as a consequence, the means of measuring a distance by the measure of a time.

To-day astronomers deal principally with the quality, the intensity, the variations of the radiations of heavenly bodies. The telescope, in spite of its magnifying power, is a very limited instrument for this purpose. But where the telescope ends, the spectroscope begins. Physicists, with the help of opticians and electricians have made single prisms, multi-prisms, gratings, interferential apparatuses, the photographic plate sensitive to red and infra-red, the water-cell, the thermo-electric couple, the photo-cell connected to radio amplifiers. The enumeration was not pressed further because, as the speaker said, "Le secret d'ennuyer est celui de tout dire"!

On the screen were presented a photograph of a Doppler-Fizeau effect obtained last year by M. Meggers of the Allegheny observatory,—a measure of radiation-intensity and the interferential experiments of M. Fabry.

As a digression was given the following English translation of a quatrain of verses by Hesiod which permits us to calculate that this Greek author lived 961 years before Christ.

> 'When from the solstice sixty wintry days
> Their turns have finished, mark, with glittering rays
> From ocean's sacred flood, Arcturus rise,
> The first to gild the dusky evening skies.'

In the same way Thales told his time when he wrote that he had seen the Pleiads setting, at the same hour as the sun rises, twenty-five days after the autumnal equinox."

At the close of the lecture Mr. J. T. Armand made a brief speech in French conveying the thanks of the audience to the lecturer.

Mr. Justice Howard then commented upon the suggestion that information regarding latitude, longitude, solar time and meteorological data be made available to the public and proposed that the Society approach McGill University in regard to this matter.

The Secretary then referred to the French physicist, the late M. Perot, quoting from the article by his confrere, M. Fabry, in the November Astrophysical Journal and showing their joint invention the Fabry-Perot parallel plate interferometer which had been kindly set up by Dr. D. A. Keys.

After the adjournment of the meeting the audience were able to view the interference pattern produced by the above device.

A. VIBERT DOUGLAS, *Secretary.*

[Other minutes held over to next issue]

The Royal Astronomical Society of Canada

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